IN THE UNITED STATES PATENT AND TRADEMARK OFFICE

In re application of:

Serial No:	10/587,701	**Art Unit:**	3663
Filed:	July 27, 2006	**Examiner:**	N/A
Subject:	MULTI-USER ADAPTIVE ARRAY RECEIVER AND METHOD		
Allowed:	October 25, 2010	**Issue Fee due:**	January 25, 2011

THE HONORABLE COMMISSIONER OF PATENTS AND TRADEMARKS
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P.O. Box 1450, Alexandria VA 22313-1450
U.S.A.

SUPPLEMENTAL INFORMATION DISCLOSURE STATEMENT
AFTER ALLOWANCE BUT BEFORE ISSUE FEE PAYMENT

Sir:

Submitted herewith is form PTO/SB/08A listing eight patent documents cited by the Japanese patent office in a first office action issued in August 2010 in respect of a corresponding Japanese patent application. The claims presently of record in the corresponding Japanese application are still those published in the parent PCT application, whereas the claims in the recently-allowed present application serial number 10/587,701, derived from the same PCT application, include distinguishing limitations. Consequently, the eight cited patent documents are considered to be cumulative to the prior art information already of record in the USPTO and considered by the examiner.

Notwithstanding that the contents of the eight patent documents are considered to be cumulative, to ensure completeness of the record, copies of the eight patent documents are submitted herewith and a discussion of the eight patent documents begins on page 2 of this paper.

Certification under 37 C.F.R. § 1.98(e)

Unfortunately, it is now just over three months since the Japanese patent office issued the office action so it is understood that a certification under 37 C.F.R. § 1.98(e) cannot be made. Notwithstanding that, the examiner is respectfully requested to consider these documents and related discussion anyway, and charge the appropriate fee of $180.00 under 37 C.F.R. § 1.17(p) to deposit account number 20-0771.

Relevance of information not in English - 37 CFR 1.98(a)(3)

For each reference not in English, a copy of an equivalent English-language patent document is submitted herewith.

The submission of any document herewith, which is not a statutory bar, is not intended as an admission that such document constitutes prior art against the claims of the present application. Applicant does not waive any rights to take any action which would be appropriate to antedate or otherwise remove as a competent reference any document which is determined to be a *prima facie* prior art reference against the claims of the present application.

This paper is being submitted using EFS and the Commissioner will by authorized to charge any fee required to my credit card or to Deposit Account No. 20-0771.

Respectfully submitted

/tadams/

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D1 (JP2003-152603 English equivalent US2002/0161560) discloses a turbo detection-based receiver which proceeds by first estimating the interference affecting the desired signal and subtracting it (interference cancelling) to produce a version of the received signal which is almost interference free. Linear adaptive filtering based on the minimum mean-square error (MMSE) criterion is then applied to reduce the residual interference. This differs from the present invention, as claimed, in multiple ways. Firstly, D1 relies on multiple non-linear techniques, including component channel decoders (such as BCJR or MAP decoders) providing soft-decision information, and interference cancelling. Embodiments of the present invention are much simpler and avoid any such technique. Secondly, D1 tackles interference in the first step through interference reconstruction and cancelling, whereas embodiments of the present invention do not tackle interference at all in the first step. Rather, the first step is strictly a means of reducing the number of dimensions in the problem. Interference is then handled in the second step through interference nulling.

D2 (JP2006-515471 English equivalent WO2005/036776) discloses a multiple antenna system within a multiple-input multiple-output (MIMO) context. The system described therein also comprises two space-time filtering steps applied sequentially, yet it is very different in purpose and technology from the present invention. The first space-time filtering step therein aims to reduce co-channel interference, while the second aims to reduce inter-symbol interference. However, in embodiments of the present invention, the first step is designed to reduce the number of dimensions, and both co-channel and inter-symbol interference are tackled in the second step. This approach provides complexity advantages over such prior art as D2 in multiple scenarios.

D3 (JP2004-354377 English equivalent US2004/0253987) discloses a system comprising two antenna arrays designed to estimate the directions of arrival of impinging signals in two dimensions. Assuming that the signal sources are "spread" and cannot be resolved to a single direction of arrival, the system estimates a "central" or "primary" direction of arrival. This is completely different from embodiments of the present invention which at no point rely upon direction of arrival estimation. The techniques relied on in D3, which are part of the "superresolution" class (such as TLS-ESPRIT), are completely different. Embodiments of the present invention derive subspaces of maximum energy in an abstract mathematical space through linear transformations without reducing to a main direction of arrival, which would be counterproductive (since some energy would be lost and the processing burden would be higher).

D4 (JP2005-152435 English equivalent US2005/0047515) discloses a partial eigendecomposition of the overall covariance matrix in an array receiver in order to regularize the weight computations when not enough snapshots are available. There is no preprocessing reducing the number of dimensions to process through adaptive filtering. Furthermore, the eigendecomposition in this case is performed on the overall covariance matrix of the received signal at all antenna elements, whereas in embodiments of the present invention, an eigendecomposition is performed on the covariance

matrix of each user's distinct received signal (isolated through correlation with a training sequence). Finally, it is noted that in D4 the eigendecomposition is applied as a preliminary step in computing the weight vector according to the minimum mean-square error (MMSE) criterion, while, in embodiments of the present invention, the eigenvectors themselves constitute the filter coefficients in the preprocessing section.

D5 (JP11-502896 English equivalent WO96/30964) discloses a transmitter-side beamforming technique where a set of orthogonal signals are formed using orthogonal filters, and the said signals are then transmitted on different beams formed by the antenna array. Since the signals are already orthogonal, they can easily be separated at the receivers whereas, in embodiments of the present invention, the receiver relies on spatial filtering to separate competing signals which have no such orthogonal property. To achieve this, embodiments of the present invention limit complexity by exploiting knowledge of the respective channel's subspace structure. No such technique is employed in D5 and it is submitted that there is no correlation with the present invention.

D6 (JP2007-503767 English equivalent WO03/050559) discloses a joint transmitter / receiver scheme which differs from embodiments of the present invention because it is not a multi-user scenario, but rather a point-to-point scenario where multiple antennas are used at the transmitter and one or more are used at the receiver. The scheme relies heavily on processing at the transmitter, whereas embodiments of the present invention assume no special processing at the plurality of independent transmitters (since the present invention is concerned with a multi-user scenario). The joint processing at transmitter and receiver in D6, termed "eigensteering," is based on the eigendecomposition of the channel matrix H's correlation matrix, i.e., R=HHH whereas the dominant subspace filtering in embodiments of the present invention is based on eigenvectors of the individual user signal's covariance matrices. Therefore, the technique is different, and the goal is also different, since D6 does not exploit eigendecomposition in order to reduce the number of dimensions, but rather to maximize coupling between transmitter and receiver.

D7 (JP2003-283394 English equivalent US2005/0153657) discloses a multi-beam transmitter / receiver arrangement where the best transmitter beam and the best receiver beam is selected with respect to some quality criterion. This is a joint transmitter / receiver optimization scheme and a point-to-point scenario, without multi-user interference. In contrast, in embodiments of the present invention the intention is to function in multi-user systems without assuming any special processing at the transmitter. Furthermore, D7 relies on a set of predetermined directional beams at both transmitter and receiver from which best candidate beams can be selected. Embodiments of the present invention do not rely on predetermined beams of any kind, and do not create beams which target a specific direction. Rather, the dominant subspace filters create spatial signatures or patterns which may have one or more distinguishable beams, one or more nulls, or in fact have any geometrical shape as appropriate based on the spatial signatures of impinging signals.

D8 (JP10-224282 English equivalent US2003/0019455) discloses a diversity receiver with equalization where training is performed both within a known training sequence and during the data payload (through decision-directed adaptation). In order to improve reception quality, D8 provides a structure which performs training multiple times in order to improve quality of the channel parameter estimates (and thus, indirectly, of the received signal). D8 seeks to improve reception quality. It does not address the complexity issue. It is in fact very close to the canonical receiver discussed in the present applicant's original PCT application, in the paragraph, in the paragraph beginning at page 4, line 22, since all taps (or degrees of freedom) need to be dynamically adapted on a continuous basis. Furthermore, D8 ends up being more complex than the canonical receiver because of the multiple training steps. More importantly, unlike embodiments of the present invention, it does not perform a preprocessing step to reduce the number of degrees of freedom that require rapid processing.